

WHAT IS CLAIMED IS:

1                   1.       A method for reducing noise effects in a system for measuring a  
2 physiological parameter, the method comprising the steps of:  
3                   generating a plurality of measurements derived from at least one  
4 wavelength of electromagnetic energy transmitted through living tissue;  
5                   comparing selected measurements with at least one expected measurement  
6 characteristic;  
7                   assigning one of a plurality of variable weights to each selected  
8 measurement based on the comparing step thereby generating a plurality of differently  
9 weighted measurements, the variable weights being assigned, in part, in response to a  
10 similarity between each selected measurement and a corresponding previous  
11 measurement, the variable weights comprising a plurality of different non-zero numbers;  
12 and  
13                   averaging a plurality of the differently weighted measurements to obtain a  
14 filtered measurement for use in estimating the physiological parameter.  
15

1                   2.       A method for reducing noise effects in a system for measuring a  
2 physiological parameter, the method comprising the steps of:  
3                   generating a plurality of measurements corresponding to a series of cardiac  
4 pulses;  
5                   comparing each measurement with at least one expected measurement  
6 characteristic;  
7                   assigning a variable weight to each measurement based on the comparing  
8 step, thereby generating a plurality of differently weighted measurements; and  
9                   averaging a plurality of the differently weighted measurements from  
10 successive pulses to obtain a filtered measurement, each differently weighted  
11 measurement corresponding to a particular filtered measurement being similarly situated  
12 in a corresponding one of the successive pulses.

1                   3.       An apparatus for reducing noise effects in a system for measuring a  
2 physiological parameter, comprising:

means for generating a plurality of measurements corresponding to a series of cardiac pulses;

means for comparing each measurement with at least one expected measurement characteristic;

means for assigning a variable weight to each measurement based on the comparing step, thereby generating a plurality of differently weighted measurements; and

means for averaging a plurality of the differently weighted measurements from successive pulses to obtain a filtered measurement, each differently weighted measurement corresponding to a particular filtered measurement being similarly situated in a corresponding one of the successive pulses.

4. A method for reducing noise effects in a system for measuring a physiological parameter, the method comprising the steps of:

generating a plurality of measurements derived from one wavelength of electromagnetic energy transmitted through living tissue;

comparing selected measurements with at least one expected measurement characteristic;

assigning one of a plurality of variable weights to each selected measurement based on the comparing step thereby generating a plurality of differently weighted measurements, the plurality of variable weights comprising a plurality of different non-zero numbers; and

averaging a plurality of the differently weighted measurements to obtain a filtered measurement.

5. A method for reducing noise effects in a system for measuring a physiological parameter, the method comprising the steps of:

generating a plurality of time-based measurements which are not event driven, the time-based measurements being derived from at least one wavelength of electromagnetic energy transmitted through living tissue;

comparing selected time-based measurements with at least one expected measurement characteristic;

assigning one of a plurality of variable weights to each selected time-based measurement based on the comparing step thereby generating a plurality of differently

10 weighted time-based measurements, the variable weights comprising a plurality of  
11 different non-zero numbers; and

12 averaging a plurality of the differently weighted time-based measurements  
13 to obtain a filtered time-based measurement.

1 6. An apparatus for reducing noise effects in a system for measuring a  
2 physiological parameter, comprising:

3 means for generating a plurality of time-based measurements which are not  
4 event driven, the time-based measurements being derived from at least one wavelength of  
5 electromagnetic energy transmitted through living tissue;

6 means for comparing selected time-based measurements with at least one  
7 expected measurement characteristic;

8 means for assigning one of a plurality of variable weights to each selected  
9 time-based measurement based on the comparing step thereby generating a plurality of  
10 differently weighted time-based measurements, the variable weights comprising a  
11 plurality of different non-zero numbers; and

12 means for averaging a plurality of the differently weighted time-based  
13 measurements to obtain a filtered time-based measurement.

1 7. A method for measuring a blood constituent using data comprising  
2 a single data set, the method comprising the steps of:

3 determining a plurality of possible blood constituent values using a  
4 plurality of blood constituent value calculators, each of the blood constituent value  
5 calculators using the single data set, each of the possible blood constituent values having  
6 a confidence level associated therewith based on at least one quality metric; and

7 arbitrating between the plurality of possible blood constituent values with  
8 regard to the confidence levels to determine a measure of the blood constituent.

1 8. An apparatus for measuring a blood constituent using a single data  
2 set, comprising:

3 means for determining a plurality of possible blood constituent values  
4 using a plurality of blood constituent value calculators, each of the blood constituent

5 value calculators using the single data set, each of the possible blood constituent values  
6 having a confidence level associated therewith based on at least one quality metric; and  
7 means for arbitrating between the plurality of possible blood constituent  
8 values with regard to the confidence levels to determine a measure of the blood  
9 constituent.

1 9. A method for generating a pulse rate of a patient using data  
2 corresponding to at least one wavelength of electromagnetic energy transmitted through  
3 tissue of the patient, the method comprising the steps of:  
4 defining a comb filter to isolate signal energy in the data corresponding to  
5 a fundamental frequency and related higher frequency components thereof;  
6 determining a particular frequency which optimizes energy at an output of  
7 the comb filter; and  
8 generating a filtered pulse rate corresponding to the particular frequency.

1 10. An apparatus for generating a pulse rate of a patient using data  
2 corresponding to at least one wavelength of electromagnetic energy transmitted through  
3 tissue of the patient, comprising:  
4 means for defining a comb filter to isolate signal energy in the data  
5 corresponding to a fundamental frequency and related higher frequency components  
6 thereof;  
7 means for determining a particular frequency which optimizes energy at an  
8 output of the comb filter; and  
9 means for generating a pulse rate corresponding to the particular  
10 frequency.

1 11. A method for determining a patient's pulse rate using data  
2 comprising a single data set corresponding to energy transmitted through the tissue of a  
3 patient, the method comprising the steps of:  
4 determining a plurality of possible pulse rates using a plurality of pulse  
5 rate finders, each of the pulse rate finders using the single data set, each of the possible  
6 pulse rates having a confidence level associated therewith based on at least one quality  
7 metric; and

8 arbitrating between the plurality of possible pulse rates with regard to the  
9 confidence levels to determine the patient's pulse rate.

1 12. A method for determining a pulse rate of a patient using data  
2 corresponding to at least one wavelength of electromagnetic energy transmitted through  
3 tissue of the patient, the method comprising the steps of:

4 tracking a fundamental frequency using an adaptive comb filter to filter the  
5 data and to thereby generate a first pulse rate, the first pulse rate having a first  
6 confidence level associated therewith based on at least one quality metric;

7 comparing the data to a predetermined waveform template to generate a  
8 second pulse rate, the second pulse rate having a second confidence level associated  
9 therewith based on the at least one quality metric; and

10 arbitrating between the first and second pulse rates with regard to the first  
11 and second confidence levels to determine the patient's pulse rate.

1 13. In a system for measuring a physiological parameter using at least  
2 one wavelength of electromagnetic energy transmitted through living tissue, a method for  
3 determining an operational status of the system comprising the steps of:

4 receiving a data signal from at least one sensor;

5 determining whether the received data signal is representative of the  
6 physiological parameter by sensing whether the at least one sensor is secured to the  
7 living tissue; and

8 generating a status signal representative of the operational status of the  
9 system based on the determining step.  
10

1 14. An apparatus for reducing noise effects in a system for measuring a  
2 physiological parameter, comprising:

3 means for generating a plurality of measurements derived from at least one  
4 wavelength of electromagnetic energy transmitted through living tissue;

5 means for providing a signal indicative of the at least one wavelength of  
6 electromagnetic energy;

7 means for comparing selected measurements with at least one expected  
8 measurement characteristic;

means for assigning one of a plurality of variable weights to each selected measurement based on the comparing step thereby generating a plurality of differently weighted measurements for each wavelength, the variable weights being assigned, in part, in response to a similarity between each selected measurement and a corresponding previous measurement, the variable weights comprising a plurality of different non-zero numbers;

means for averaging a plurality of the differently weighted measurements to obtain a filtered measurement for use in estimating the physiological parameter; and

means for calibrating the system to measure the physiological parameter in response to the signal indicative of the at least one wavelength of electromagnetic energy.

15. A monitor for measuring a physiological parameter, the monitor being for use with a sensor having emitting means for emitting at least one wavelength of electromagnetic energy, sensing means for sensing the electromagnetic energy and for generating a first signal representative thereof, means for detachably coupling the sensor to the oximeter and for providing communication of signals between the sensor and the oximeter, and means for providing a second signal indicative of the at least one wavelength of electromagnetic energy, the monitor comprising:

means for generating a plurality of measurements derived from the first signal;

means for comparing selected measurements with at least one expected measurement characteristic;

means for assigning one of a plurality of variable weights to each selected measurement based on the comparing step thereby generating a plurality of differently weighted measurements, the variable weights being assigned, in part, in response to a similarity between each selected measurement and a corresponding previous measurement, the variable weights comprising a plurality of different non-zero numbers;

means for averaging a plurality of the differently weighted measurements to obtain a filtered measurement for use in estimating the physiological parameter; and

means for calibrating the monitor to measure the physiological parameter in response to the second signal.

1                   16.     A method for measuring a blood constituent using data  
2 corresponding to a wavelength of electromagnetic energy transmitted through tissue of a  
3 patient, the method comprising the steps of:  
4                   filtering the data such that motion and noise energy not at integer multiples  
5 of a heart rate of the patient are attenuated, thereby generating filtered data;  
6                   comparing selected filtered data with at least one expected data  
7 characteristic;  
8                   assigning one of a plurality of variable weights to each selected filtered  
9 data based on the comparing step thereby generating a plurality of differently weighted  
10 filtered data, the variable weights comprising a plurality of different non-zero numbers;  
11 and  
12                   averaging a plurality of the differently weighted filtered data to obtain a  
13 twice-filtered data for use in estimating the blood constituent.

1                   17.     A method for calculating oxygen saturation of hemoglobin in  
2 arterial blood using data corresponding to a plurality of wavelengths of electromagnetic  
3 energy transmitted through tissue of a patient, the method comprising the steps of:  
4                   determining extinction coefficients corresponding to the plurality of  
5 wavelengths; and  
6                   calculating values proportional to total hemoglobin and oxygenated  
7 hemoglobin directly from the data and the extinction coefficients.